

NIST Boulder is located in a rich research environment near the University of Colorado (CU) Boulder, and collaborates with industrial, academic, and government laboratories throughout the nation and the world. NIST and CU-Boulder jointly operate JILA, a world leader in atomic, molecular, and optical physics and precision measurement.

NIST Boulder has more than 350 scientific, technical, and support staff, and more than 300 visiting researchers, students, and contractors. NIST Boulder and NIST/JILA scientists have been awarded three Nobel Prizes in physics, a National Medal of Science, and two MacArthur Fellowship “genius grants.”

With an annual research and measurement budget of about \$100 million, NIST Boulder is part of the U.S. Department of Commerce’s National Institute of Standards and Technology, headquartered in Gaithersburg, Md.

CONTACT:

Dr. Kent B. Rochford, Director
NIST Boulder Laboratories
Communications Technology Laboratory
(303) 497-5285 kent.rochford@nist.gov

NATIONAL INSTITUTE of STANDARDS and TECHNOLOGY

NIST BOULDER LABORATORIES: PRECISION MEASUREMENTS TO SUPPORT INNOVATION

A world leader in the physical sciences and precision measurement for more than 60 years, **NIST Boulder Laboratories** provide research, measurements, technology, tools, data, and services that enable innovation and improve the quality of our lives.

Support for Manufacturing and

Innovation: NIST Boulder develops and supplies measurement tools, test methods, and scientific data that businesses need to invent, innovate, and produce high-quality products for electronics, communications, optics, nanotechnology, public safety, biosciences, forensics, defense, and environmental applications.

Technologies for Everyday Life: NIST Boulder makes possible many commonplace technologies—such as accurate wristwatches and GPS navigation systems, advanced communications networks, DVD players, safe laser surgery, and reliable gas pipelines.

Technology Transfer: NIST Boulder generates spin-off companies and jobs and provides industry, academia, and other federal agencies with cutting-edge technologies. Commercial products influenced by NIST Boulder-pioneered technologies include closed captioning and chip-scale atomic clocks. NIST technologies used by other labs include frequency combs, quantum sensors, laser power meters, single-photon detectors, and magnetometers.

RESEARCH AND SERVICES HIGHLIGHTS

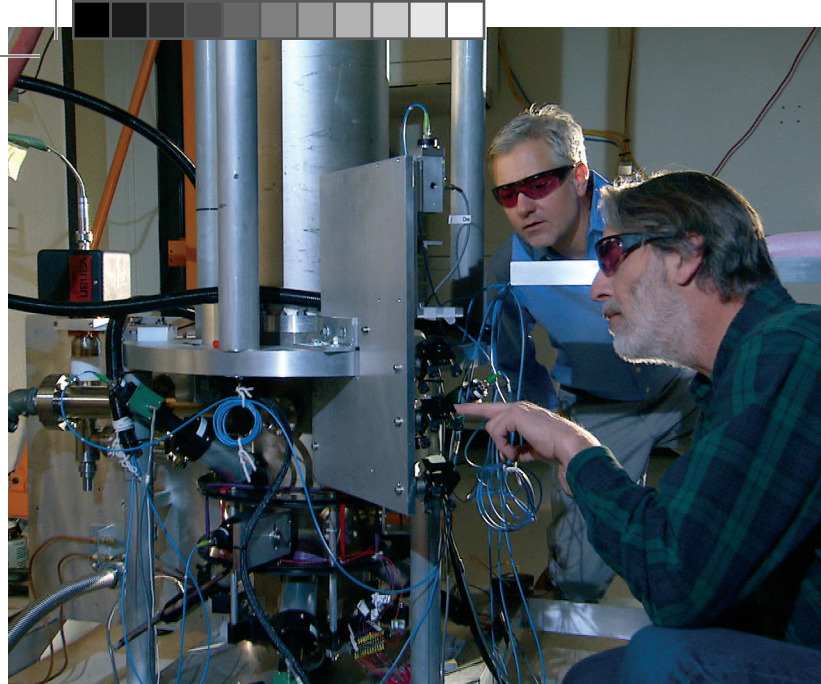
Timekeeping: Computer clocks and other timekeeping devices are linked to the U.S. civilian standard atomic clocks, NIST-F1 and NIST-F2, located at NIST Boulder. NIST official time is disseminated to devices via the Internet about 7 billion times a day (as of late 2014). NIST time also regularly updates about 50 million devices by radio and is used to time-stamp hundreds of billions of dollars in financial transactions every business day. NIST precision time standards underpin telecommunications systems, GPS positioning and navigation, electric power distribution, and TV and radio broadcasts. NIST also develops world-leading next-generation atomic clocks.

Advanced Communications: NIST has pioneered communications technologies for many decades, beginning in the early days of radio. The current focus is on the latest wireless advances, including cellular and data communications and public safety networks. NIST Boulder conducts advanced research related to materials, waveform measurements, antennas, and networks and develops instruments and methods for testing next-generation “5G” cellular devices and systems. NIST Boulder also supports a collaborative test bed to improve public safety communica-

www.nist.gov

cover photo:
Christina Kiffney Photography

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce



The newest U.S. civilian time standard, NIST-F2 is the world's most accurate time standard (as of late 2014).
Credit: NIST

tions, and a national network of federal, academic, and commercial test facilities to help develop and deploy technologies for sharing wireless channels, or spectrum.

Laser Measurements and Applications: NIST Boulder provides tools and services for measuring laser power, energy, and safety. This helps to ensure quality control in manufacturing and improve products and processes for telecommunications, health care, cutting and welding of materials, and defense applications. NIST Boulder offers calibrations for a greater range of laser wavelengths and power levels than any other national metrology institute in the world. NIST's ultraprecise laser frequency combs—tools for measuring individual colors of light—are used for timekeeping, greenhouse gas monitoring, remote 3D imaging, and calibrating astronomical instruments to search for Earth-like planets.

Quantum Devices: NIST Boulder is the world leader in microelectronic devices that use quantum physics to perform otherwise impossible measurements. These superconducting systems continue to

revolutionize the way the world measures voltage, counts individual particles of light, and explores the use of artificial atoms in experimental quantum computing. NIST voltage standards are used by industry, government, and military labs to calibrate voltmeters for applications such as the electric power grid and consumer electronics. NIST sensors and amplifiers are deployed on telescope cameras around the world.

Materials Properties and Reliability: NIST Boulder researchers evaluate the reliability of materials ranging from nanometer-sized electronic devices to large sections of gas pipelines, and measure mechanical and fatigue properties at temperatures ranging from well below zero to more than 1100 °C. NIST Boulder also houses the nation's leading laboratory for measuring industrially important properties of fluids. The work has diverse impacts, from

contributing to novel techniques for arson investigation to improving the reliability of chemical data.

ADVANCED FACILITIES AVAILABLE FOR COLLABORATIONS

700 MHz Public Safety Broadband Demonstration Network

NIST is a partner in the Public Safety Communications Research program, which operates a multi-vendor demonstration site enabling manufacturers, carriers, and public safety agencies to test and evaluate advanced broadband communications equipment and software for emergency first responders.

Boulder Microfabrication Facility

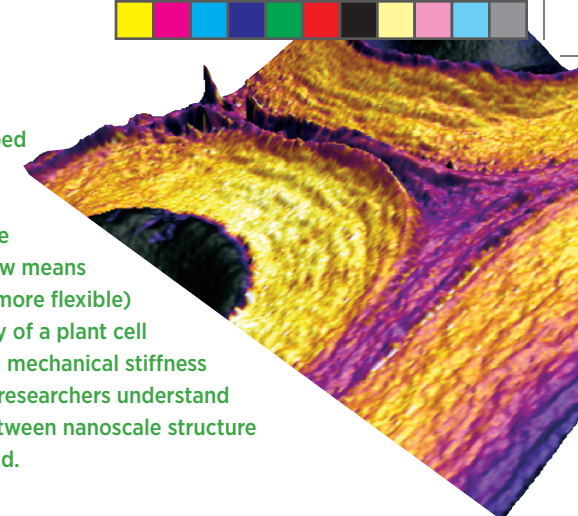
NIST designs and produces custom microfabricated devices for its research and measurements to support electrical standards, homeland security,

NIST staff are conducting research on advanced communications to improve broadband wireless and the quality and interoperability of public safety communications.

Credit: Paul Trantow/Altitude Arts



A NIST-developed microscopy technique was used to map the elasticity (yellow means stiffer; purple, more flexible) and topography of a plant cell wall. Measuring mechanical stiffness in plants helps researchers understand correlations between nanoscale structure and biofuel yield.
Credit: NIST



quantum sensors, and quantum computing experiments. NIST Boulder also fabricates unique devices used by external partners for applications such as precision astronomical research and laser radiometry. The facility houses more than 50 deposition and etching systems for microelectronics fabrication.

Precision Imaging Facility

NIST Boulder provides four instruments for precisely measuring the structure and chemical composition of materials at sub-nanometer scales: a helium ion microscope, a focused ion beam/scanning electron microscope, a transmission electron microscope, and a field ion microscope, or atom probe.

Inspecting a wafer inside a process chamber in the Boulder MicroFab, a crucial resource for NIST research.
Credit: NIST

